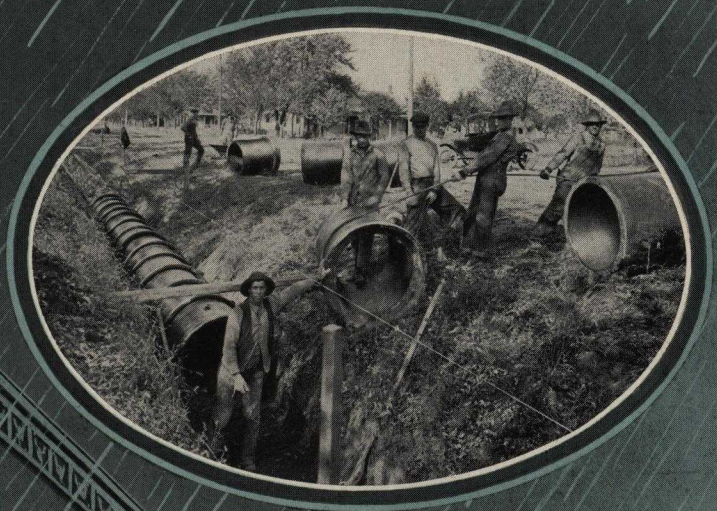
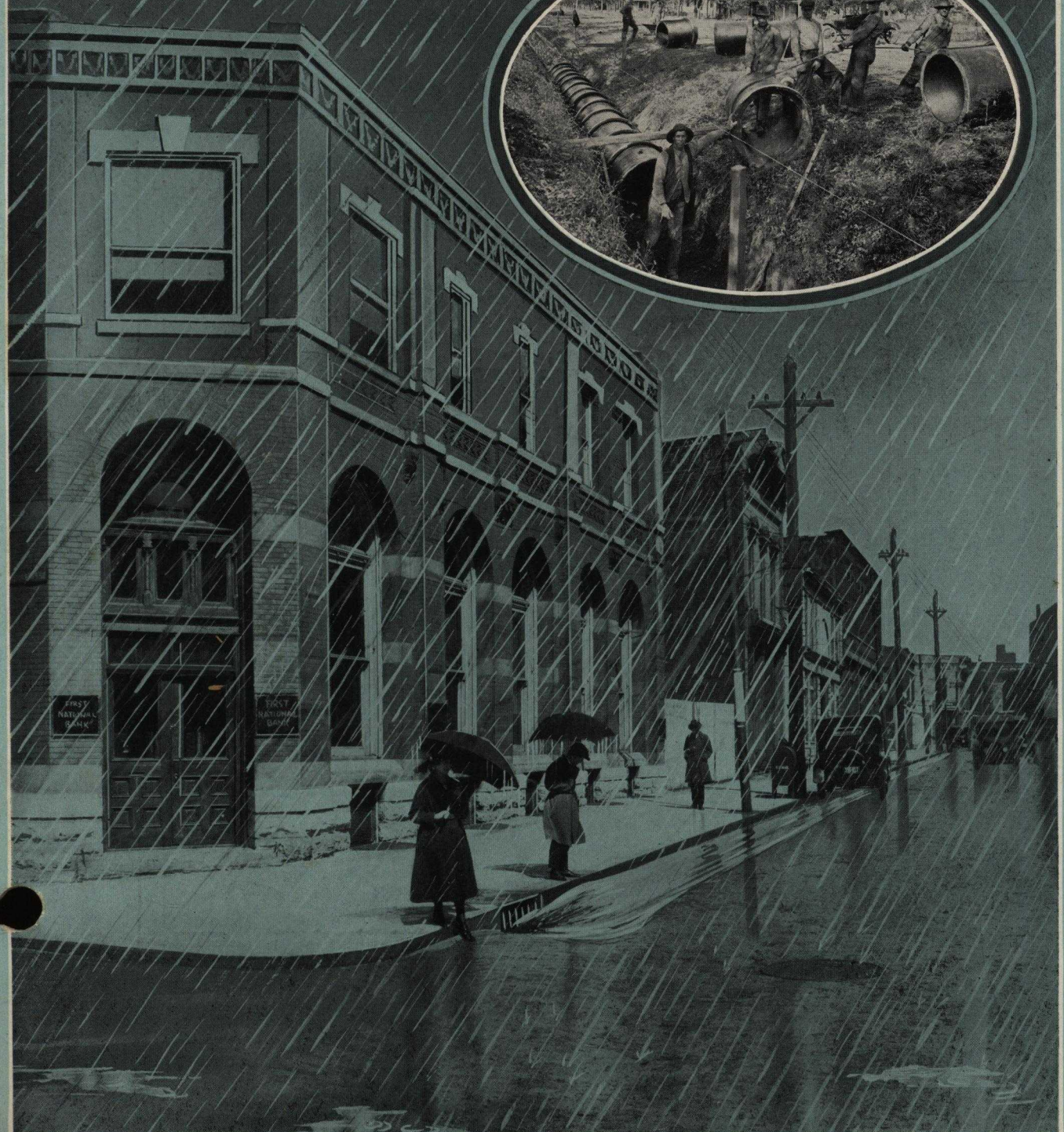
STORM SEWERS
PREVENT FLOODED STREETS





Investing for Maximum Returns

PUBLIC OFFICIALS, progressive citizens and Engineers are each and all interested in making the public funds produce the best and most permanent improvements possible. It sometimes happens that the utmost in results is not fully attained because all are not equally informed as to the particular method which would assure the desired maximum of benefits.

Our purpose in issuing this booklet, then, is to bring added light to all those interested in the subject of Paving or Street Improvements so that they may recognize the importance of Storm Sewers.

We believe that two guiding and fundamental propositions should control when municipal improvements are being considered:

First, Each municipal improvement should be considered primarily from the standpoint of an investment. There naturally follows the question of how to make it yield its maximum of beneficial returns to the citizens making the investment.

Second, If a slightly increased initial outlay of funds will yield a greatly increased return in benefits and also add security to the whole project, then it is unquestionably wise and proper to adopt the enlarged program.

With these two fundamentals in mind, we invite you to the further consideration of the subject of Storm Sewers and the materials best adapted to their construction.

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Cut No. 2208—Photograph taken at intersection of Monette and Boyd Streets, Norman, Oklahoma. Shows a combination of Pavement and Storm Sewers. Note the inlets to Storm Sewer through curbing. Both Vitrified, Salt Glazed Sewer Pipe and Dickey Segment Blocks were used in the Storm Sewers. Peckham, Sutton and James, Consulting Engineers, Oklahoma City, Okla. M. R. Amerman, Contractor, Wichita, Kans.

Commendable Pride a Valuable Asset To a City

THE evolution of a street from a beaten path or a mere diagram on a plat to a well paved and adequately drained thoroughfare usually implies a story of the ambition and the civic pride of progressive officials and citizens in the community. Such citizens are benefactors whose efforts for worthy and attainable improvements lift the town out of the mud locally and into a position of prestige among the neighboring municipalities.

Unpaved streets may be likened to the soiled linen or the unpolished shoes of an individual. They are not a thing to be proud of. In fact, they tend to encourage negligence and untidiness in even the most progressive citizen. Pavements, curbings, sidewalks and storm sewers for drainage all produce an atmosphere conducive to commendable civic pride. These improvements usually result in an increased interest in betterments being manifested by homeowners and business men alike. They vie with one another in maintaining the community's smart appearance and the whole aspect of the town is changed.

Cut No. 2143—Laying Vitrified, Salt Glazed, Clay Pipe for Storm Sewers at St. John, Kansas. 24-inch pipe laid in shallow ditches. W. B. Rollins, Engineer, Kansas City, Missouri. Cook and Ransom, Contractors, Ottawa, Kansas.

Utility and Beauty Should be Combined

COMBATING the elements and the natural obstacles in order to obtain uninterrupted travel and rapid communication has been the concern of both the frontiersman and the city dweller. In order to reduce the existing hazards and clear away the hindering obstacles, they have expended millions in money and years of labor to construct Roads, Bridges, Railways, Viaducts, Tunnels, Ships, Telephones, Telegraph, etc.

Wherever they have built, it has become necessary to consider a method of protecting the improvements from storms, floods, wear and tear, disintegration and decay.

City builders naturally desire to improve the streets. They want pavements which will facilitate travel in all kinds of weather. They want to be rid of dust in dry weather and mud in wet weather. They want a smooth surface instead of ruts and holes.

When a municipality decides to pave the streets, it has in mind the element of beauty as well as that of pure utility. Slime, debris or mud on a pavement are as objectionable as the dust and the mire of a dirt road. If the paved streets are to be kept clean, the storm water must be removed quickly before it accumulates and deposits mud and debris on the surface.

It is not intended that a pavement and the enclosing curbing should make a pond, a mill race or a canal out of a street. Hence, it becomes necessary to provide a down spout or storm sewer outlet to remove the storm water promptly and prevent soiled, flooded or damaged streets.

Sometimes the storm water sewer and the sanitary sewer are combined into one system. It is the province of the Engineer to determine whether such a combination is advisable. If there is no sanitary sewer system, the storm sewer must be built to conserve all the benefits which the pavement should provide.

Cut No. 2158—Construction of Storm Sewer at Hogansville, Georgia. Dickey Vitrified, Salt Glazed, Clay Segment Blocks were used to replace Corrugated Metal Pipe which had failed. Lockwood-Green Company, Engineers, Atlanta, Georgia. W. Hopson Goodloe Construction Co., Contractors, Macon, Georgia.

Full Value for the Money Expended

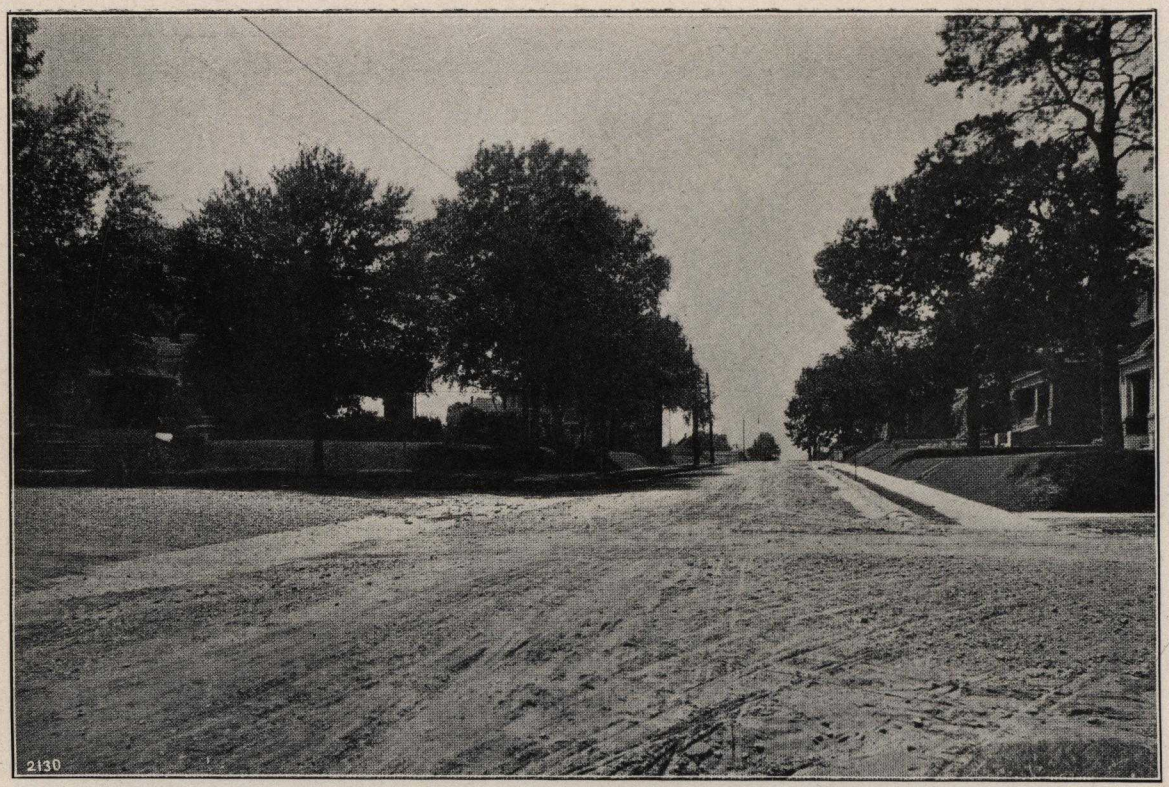
THERE are times when illadvised, so-called savings turn out to be sheer waste. The photograph shown above illustrates how one city's supposed saving eventually became a decided and costly loss. It would have been much better to have used the permanent material first. On pages six to ten, we show photographs which indicate, graphically, how another city decided to save the cost of Storm Sewers and how their decision brought them to grief.

Under Drainage Preserves the Pavement

At the right, cut No. 2017 shows the necessity for under-draining pavements where the sub-soil is wet and unstable. Heavy traffic pounding over such soft spots will eventually break down a good pavement and its foundation. Freezing and thawing and consequent heaving will also cause the failure of the pavement over these wet spots. Adequate, sub-surface drainage with permanent Vitrified Clay Drain Tile will positively eliminate this element of danger.

Cut No. 2017—Frost action in wet clay sub-soil caused the failure of a good brick pavement. The brick were laid over a 6-inch concrete base.

SAN ANTONIO SEWER PIPE WORKS, San Antonio, Texas, U. S. A.



Cut No. 2130—Someone might say, "Storm Sewer drainage is unnecessary for a section of street located at the crest of a hill such as this one." This block has not been damaged because it is carrying only its own surface water. Note Cut No. 2131, on opposite page, to see where the damage does occur.

Should a City Build Pavements Adapted to Sunshiny Weather Alone?

THE Engineer must plan not only to meet ordinary conditions, but also extraordinary and emergency contingencies. He is planning pavements to be used by vehicle traffic and pedestrian travel in all sorts of weather. What city would accept an Engineer's recommendations which read like this: "I have spared no pains to plan for pavements which will give the most satisfactory service in sunshiny, summer weather. No consideration was given to pavements suited to traffic in any other kind of weather?" It is foolish, of course, to ask the question, because no Engineer would ever present such a half-baked proposal. His training and experience lead him to make thorough and complete consideration of all the factors involved. He knows that it is not enough to plan to build a pavement and go no farther in his investigations and recommendations.

Just as the owner of the finest automobile provides himself with a set of chains for rainy or sleety weather; the architect provides a porch or veranda to protect the home-owner from sun and storm; the banker takes out burglar insurance, even though he has the most modern vault equipment; the merchant buys fire insurance, even though his new building is considered fire-proof; the Police Department of a city spends additional money to prevent riots and mob violence, so the Engineer, likewise, plans for the best pavement and then adds the Storm Sewers to make sure that none of the valuable qualities of the pavement will be lost in the event of sudden, violent storms or continued rainy weather.

Experience has taught that it pays to guard a valuable asset and that a comparatively inexpensive accessory may, in emergencies, multiply efficiency many fold.

Cut No. 2131—Three hundred feet below the undamaged section at crest of hill the damage is done by the storm water from above. The flowing water has scoured the surface, making ruts and deep gullies. Cross currents have even worn holes through the concrete gutter.

LET US consider the question of Storm Sewers as if it were raised by the report and recommendations of the City or Consulting Engineer, made to Officials and Citizens of a town in which it has been decided to install the first stretch of pavement. When the item of cost representing Storm Sewers was mentioned someone immediately raised the question, "Is this Storm Sewer an extra put into the cost or is it a necessary and vital part of the whole project?"

In answer to this question, the Engineer described as best he could two series of mental pictures he had seen in his mind's eye when he planned for Storm Sewers in addition to good pavements.

Basements Flooded During Heavy Storms

He saw in one picture a well paved street with rushing, seething streams of storm water running gutter full on the slopes and crowding over the gutters, flooding basements and ground floor business houses, in the lower levels of the city.

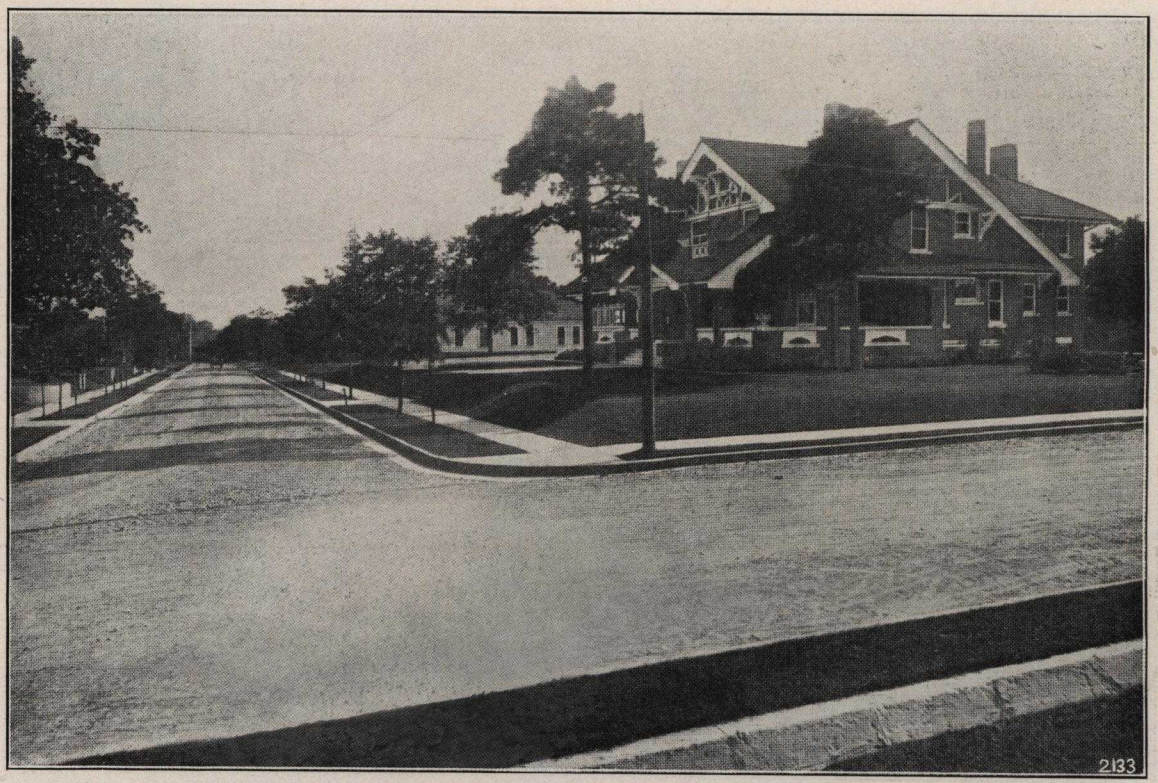
He saw, also, how men, women and children were unable to cross the wide, swift-flowing, gutter streams. They must either make a wide detour, wait for the storm to subside, wade in with the water splashing ankle to knee high, or else be carried across the swollen streams.

Mud And Debris Deposited On Pavements

After this, the Engineer watched the floating refuse and debris. He noted that it was finally deposited with slime and mud in a low spot on the pavement, or over the curb onto a sidewalk, or into an adjoining lot. He may have seen, also, a washed out section of curbing or pavement, or both, where the pavement ended or was built on filled ground

Damage Suits A Possibility

He also heard the clamor of incensed citizens at the City Hall, demanding to know of officials why such emergencies were not considered when the pavements were laid. He also imagined a picture, including a court scene, where some property owner was suing the city for damages resulting from overflowing storm water.



Cut No. 2133—The owners of this property on "Quality Hill" might question the need of Storm Sewers, since the storm water from their streets rushes on to do damage in adjoining and lower blocks.

IN DECIDED contrast to the pictures previously mentioned, there came to the Engineer another group. Each of these came to mind in connection with an enlarged plan for pavements and Storm Sewers combined. Similar showers and rain storms fell on the same pavement, but back of the lot line at the street intersections he saw inlet or catch basin openings with gratings and also manhole castings in the streets.

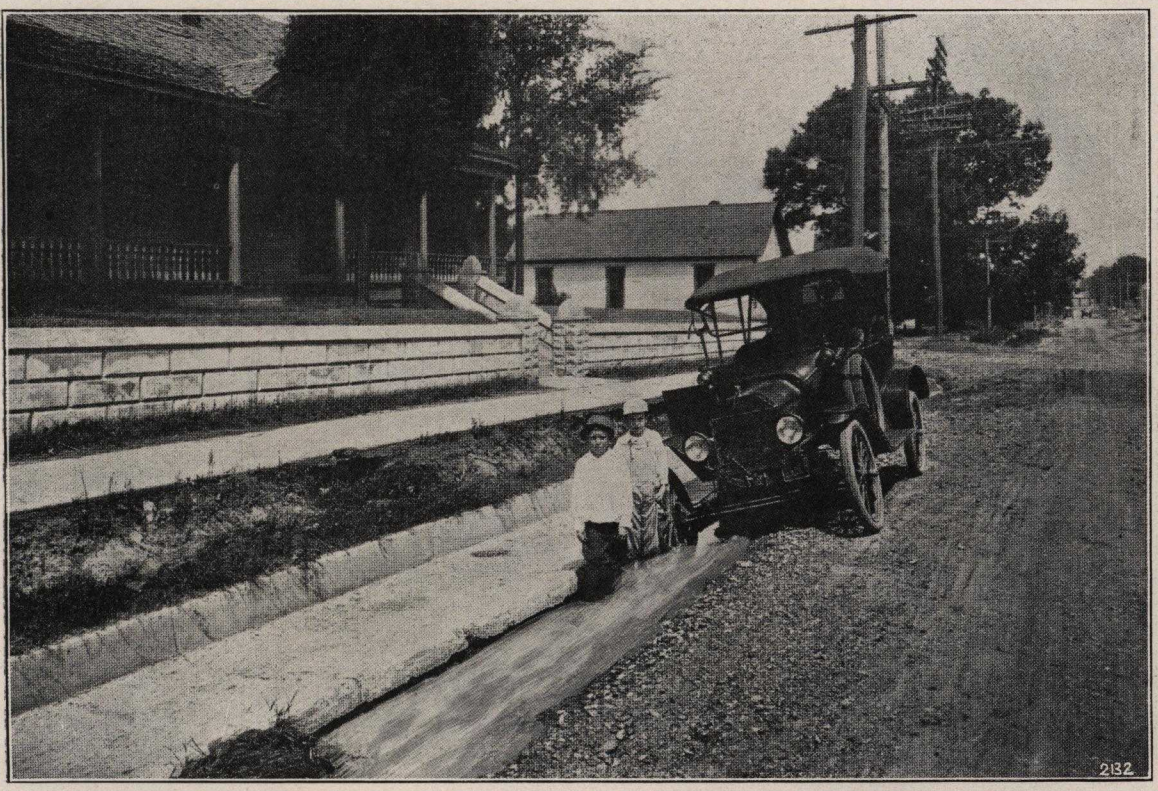
Storm Water Vanishes Into The Sewers

Because of these changes in the plan, entirely different conditions prevailed during a similar storm. The rain water accumulated rapidly on the surface of the pavement and flowed quickly in an enlarging stream down the gutter only to be swallowed out of sight at the street intersection. Again, he noticed pedestrians moving to the curb, stepping onto the slightly raised pavement beyond the inlet and passing unhindered and unwet across to the opposite sidewalk. Some people were seeking shelter, but those who were provided with umbrellas or raincoats proceeded on their errands undeterred. He was pleased to observe that no water was flowing over the curbing and that neither merchants nor home owners showed any anxiety concerning basements or cellars.

Pavements Protected And Clean

After the storm he noted that the water had not deposited refuse and rubbish along the streets. He hastened to a point where the pavement ended, fearing there might be a washout, but there was none; the water had not gathered sufficient force to do any damage. City Officials, when questioned, informed him that no complaints were registered and they were sure no court proceedings would be instituted. They were certain the Storm Sewers had taken care of the water satisfactorily.

After these contrasting pictures had passed through his mind, the Engineer declared he could not tell which group of pictures had made the greatest impression, but that the two series together left no question but what he should recommend Storm Sewers to be installed with the proposed pavement.



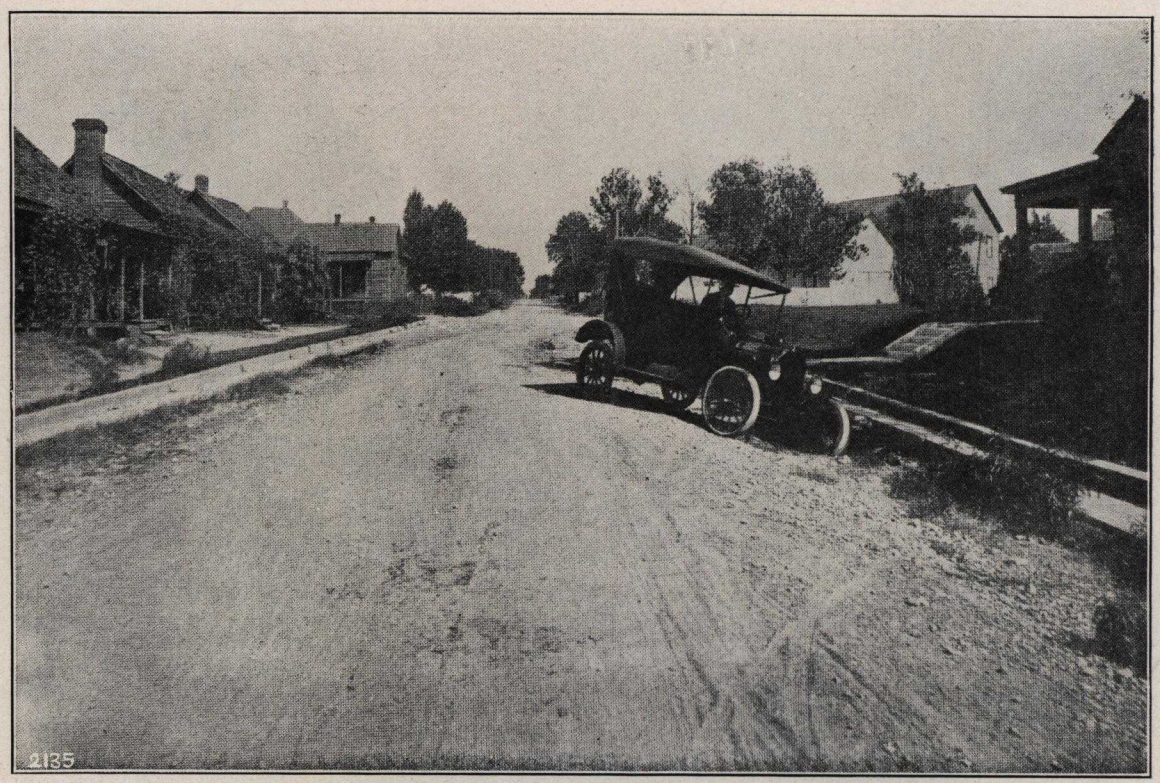
Cut No. 2132—The gully here is twelve inches below the top of the gutter. Water flowing swiftly down from "Quality Hill" will deepen and widen this gully and eventually the gutter and the curb will collapse. There should be Storm Sewer inlets or catch basins on "Quality Hill" to prevent such damage at lower points.

SOMEONE present at the meeting then suggested that as their town was in a comparatively dry climate the need for Storm Sewers might not be so great as in wetter sections, or at any rate the Sewers need not be very large to do the work. The Engineer was prepared for this suggestion because he had made careful investigations and calculations to find his own answer to it.

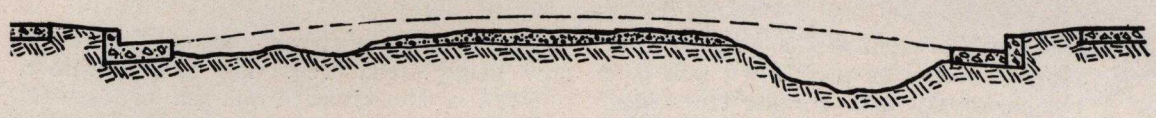
He explained how he had checked both the local and government records of rainfall; how he had considered the extremes as well as the averages for that vicinity; and how the rainfall in any climate was not constantly the same from season to season, but was variable and freakish at times, so that unprecedented, abnormal and extended wet spells might come when least expected. Moreover, he had considered the fact that more business buildings and homes would be built on lots now vacant and much additional storm water would eventually come from the roofs of these buildings onto the streets and into the Sewers now being considered. He had, therefore, allowed a conservative margin of capacity for increased, future requirements. He was certain there was not a place where the sizes recommended were larger than practical efficiency required.

Permanent Storm Sewers Are Much Too Valuable To Be Omitted

The Engineer added that he did not believe the plan for pavements should be adopted without provision being made for appropriate Storm Sewers. He felt it would be like making a steam boiler without a safety valve, or an automobile without an emergency brake. He was satisfied that the citizens would be benefited far in excess of what permanent Storm Sewers would cost. He finished by saying that if the Sewers were built of a permanent material they would not need to be replaced, even though heavy traffic might require renewal of the pavement.



Cut No. 2135—Both the photograph and the profile indicate the damaging effects of surface storm water where no Storm Sewer is provided. The paved surface is washed out at the sides and also in the center of the street, as may be seen behind the machine.



Storm Sewers Valuable to Cities of All Sizes

WHAT IS IT WORTH?" is sometimes a more pertinent and practical question than "What will it cost?" When we can say that a thing is worth all or more than it costs, then we have genuine value. The following statements of Engineers are worth quoting:

Grant, Fulton and Letton, Engineers, Lincoln, Nebraska, when referring to a dozen or more Storm Sewer installations in Nebraska, state:

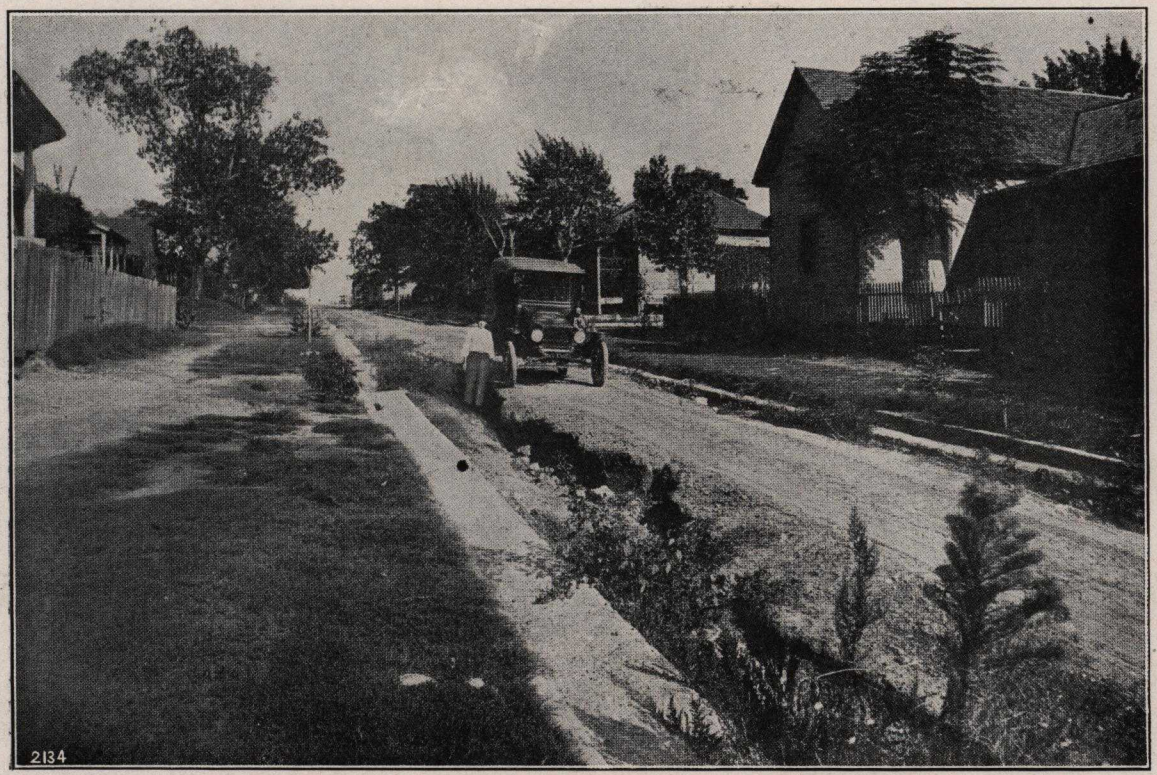
"It is our belief that Storm Sewers in connection with paving are well worth what they cost, especially when p'aced in the business section of a municipality. The use of Storm Sewers eliminates cross gutters which are a continual nuisance to vehicular traffic, and which in times of continuous rains, form a barrier very inconvenient to pedestrians. In eliminating cross gutters, it is possible to have so called level crossings which eliminate step-downs at the curb and provide a dry passageway for foot traffic at all times.

"In every instance where Storm Sewers have been constructed, we believe that the citizens of those towns have found them well worth while."

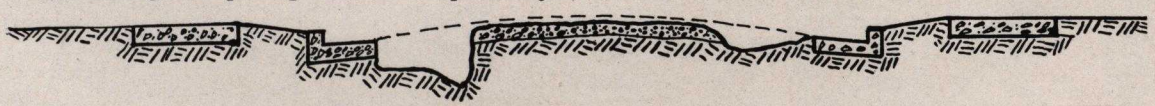
Ruckel Engineering Company, Hutchinson Kansas, state that they have consructed some ten miles of Storm Sewers and

"Whenever we are retained to design and supervise construction of paving, we generally find it advisable to also recommend the construction of Storm Sewers, since it aids in keeping the streets clean and also prevents unsanitary conditions. These conditions arise from flooded basements and debris left on the paved streets after a storm."

SAN ANTONIO SEWER PIPE WORKS, San Antonio, Texas, U. S. A.



Cut No. 2134—This miserable excuse for a street is on a connecting street within half a block of "Quality Hill." Deep gullies prevent the passing of two vehicles. The profile indicates the seriousness of the damage. Repairing will be an expensive job.



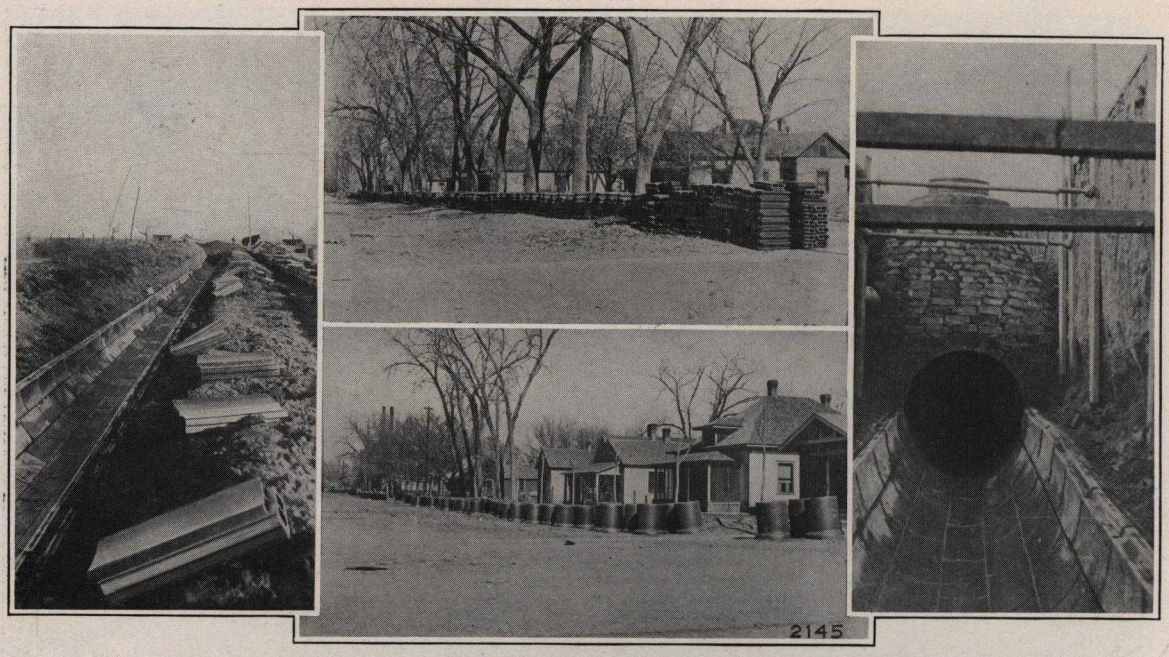
They Saved the Cost of Storm Sewers But Wasted Their More Costly Pavements

THIS SERIES of actual photographs and the three profiles on this and the opposite page portray a message and an argument to Citizens and Engineers much more emphatic and unanswerable than any we could convey in words.

The authorities in this town felt that they could not afford Storm Sewers and that they could do without them. They experimented in the face of wiser experience and lost. Had they known the truth as we and they now know it, they would have felt they could not afford the pavement until they could afford the Storm Sewer. As the illustrations show, the work should all be done over again and the Storm Sewers should be put in. Had Storm Sewers been put in at first, the pavement would still be good for years of service. The Property Owners foot the bill, the City Officials are branded as incompetents, and the Engineer is discredited. Everybody is paying what no one felt he could afford.

Cut No. 2155—This profile, taken one hundred feet below the profile shown above, indicates how the flow of the water increases in speed and destructiveness as it moves down the inclined street. The paved surface is almost all gone and the gullies are so deep that there is not clearance room for a low-hung automobile.

SAN ANTONIO SEWER PIPE WORKS, San Antonio, Texas, U. S. A.



Cut No. 2145—Construction of Storm Sewers at Rocky Ford, Colorado. 24-inch Vitrified, Salt Glazed Sewer Pipe and Dickey Segment Blocks were laid. A 42-inch Segment Block Sewer was the largest. At left, Segment Block inverted. At right, manhole construction. C. L. Patterson, Engineer, Pueblo, Colo. Burt and Tripp, Contractors, Hutchinson, Kans.

Cost of Vitrified Clay Storm Sewers Can Be Distributed Over a Long Period of Years

THIS COST varies in different cases because of the local conditions. In some instances they can be installed in shallow ditches, in others they must be placed in deep trenches. Sizes may vary, also, because of weather conditions, etc.

The following paragraph from a letter written by Grant, Fulton and Letton, Engineers, Lincoln, Nebraska, April 1, 1922, gives their experience with reference to the cost of Storm Sewers as compared to total cost of pavement and sewers:

"We have constructed Storm Sewers in connection with paving in the following Nebraska towns—Alliance, Ashland, Auburn, Broken Bow, Fairbury, Geneva, Holdrege, Red Cloud and St. Edward, and have planned Storm Sewers in connection with several other projects.

"In our experience, we find that the cost of Storm Sewers varies considerably, due to local conditions. On an average, however, it may be said that our figures show that the cost of the Storm Sewers will vary from 8% to 15% of the total cost of the pavement so sewered."

Below are comparisons showing the percentages of Storm Sewer Costs as compared to totals in cities of several states.

City	Total Cost Pavement and Storm Sewers	Per Cent Cost of Storm Sewer to Total Cost of improvement
Argenta, Ark.	$227,388.38	8 8/10%
Little Rock, Ark.....	85,071.17	9 6/10%
Little Rock, Ark.....	28,500.00	10 4/10%
Little Rock, Ark.....	Not Given	10 %
Little Rock, Ark.....	Not Given	7 5/10%
Little Rock, Ark.....	Not Given	6 %
Pine Bluff, Ark.	21,406.40	6 7/10%

City	Total Cost Pavement and Storm Sewers	Per Cent Cost of Storm Sewer to Total Cost of improvement
Pine Bluff, Ark.....	51,769.72	4 2/10%
Lake Charles, La.....	31,278.36	14 5/10%
Lake Charles, La.....	52,038.75	21 5/10%
Lake Charles, La.....	26,439.59	16 9/10%
Lake Charles, La.....	32,570.15	24 9/10%
Mount Pleasant, Tex.	19,927.09	12 4/10%

SAN ANTONIO SEWER PIPE WORKS, San Antonio, Texas, U. S. A.

Small Towns Realize the Benefits from Storm Sewers

IT IS UNIVERSALLY recognized by all large cities that Storm Sewers are inseparable from and complementary to all paving improvements. This applies to pavements in both the business and residence sections. It goes without saying that practically all cities of more than 10,000 population have built Storm Sewers.

It may seem to some residents of smaller towns that they are not in the same class as the larger cities. They therefore conclude that Storm Sewers are not needed. Such conclusions are erroneous, however, because they are not based on the facts. It would be just as logical to say that a small boy did not need two eyes, while his father who moved in a larger sphere did need two. Their fundamental needs are alike. Only the scope of their activities differ.

We list below the names of a few towns and cities having populations less than 10,000 in 1920, to show that Storm Sewers are being built everywhere in progressive, small towns and cities. Some few of these have no pavements but do have Storm Sewers. Many of these had a smaller population when Storm Sewers were first installed.

As the following is not a complete list of all the cities and towns in the various states, having Storm Sewers, it is not intended to be used for comparisons between the states mentioned.

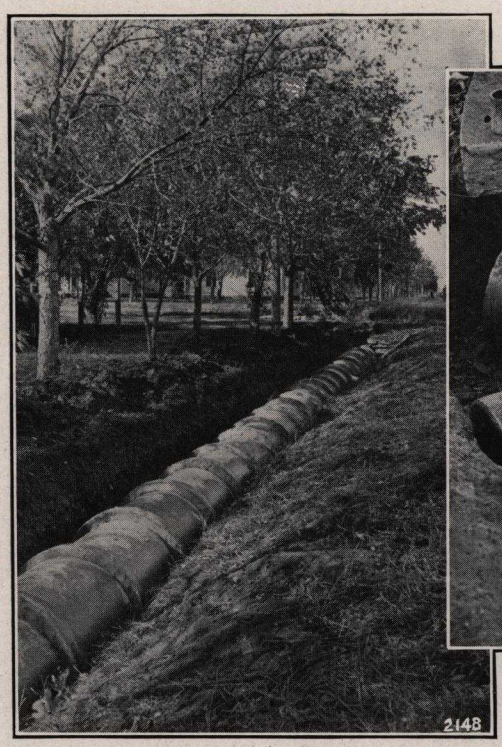
Town	Population 1920
ARKANSAS	
Argenta.	
Ashdown.	2,052
Blytheville.	6,447
Camden.	3,238
Clarksville.	2,127
Conway.	4,564
Dardanelle.	1.385
Earl.	2,091
El Dorado.	3,887
Fayetteville.	5,362
Fordyce.	2,996
Forrest City.	3,377
Helena.	9,112
Hope	4,790
Jonesboro.	9,384
Kensett.	480
Marianna.	3,995
Morrillton.	3,010
Paragould.	6,360
Russellville.	4,505
Stuttgart.	4,522
Waldo.	704
Wilmot.	627
Wynne.	2,933
COLORADO	
La Junta.	4,964
Rocky Ford.	3,746
KANSAS	
Abilene.	4,895
Augusta.	4,219
Belleville.	2,254
Beloit.	3,315
Burlington.	2,236
Caldwell.	2,191
Caney.	3,427
Cawker City.	788
Chapman.	853
Cherryvale.	4,698
Clay Center.	3,715
Concordia.	4,705
Council Grove.	2,857
Douglas.	1,010
Downs.	1,508
Ellis.	1,876
Florence.	1,455
Great Bend.	4,460
Hiawatha.	3,223
Hoisington.	2,395
Humboldt.	2,525
Iola.	8,513
Junction City.	7,533
Liberal.	3,613
Manhattan.	7,989
Marysville.	3,048
McPherson.	4,595
Neodosha.	3,943
Nickerson.	1,049
Olathe.	3,268
Ottawa.	9,018
Peabody.	2,455
Plainville.	1,004
St. John.	1,671
Stafford.	1,752
Wamego.	1.585
Winfield.	7,933
LOUISIANA	
DeRidder.	3,535
Homer.	3,305
Houma.	5,160
Lafayette.	7,855
New Iberia.	6,278
Rushton.	3,389
MISSOURI	
Booneville.	4,665
Brookfield.	6,304
Cameron.	3,248
Caruthersville.	4,750
Chillicothe.	6,525
Excelsior Springs.	4,165
Fulton.	5,595
Marshall.	5,290
Mexico.	6,013
Nevada.	7,139
Poplar Bluff.	8,042
Rich Hill.	2,261
Rockport.	1,136
Trenton	6,951
Warrensburg.	4,811
Webb City.	7,807
NEBRASKA	
Alliance.	4,591
Ashland.	1,725
Auburn.	2,863
Bayard.	2,127
Beatrice.	9,664
Broken Bow	2,567
Central City.	2,410
Chadron.	4,412
Columbus.	5,410
Deshler.	944
Fairbury.	5,454
Falls City.	4,930
Fremont.	9,605
Geneva.	1,768
Havelock.	3,602
Holdrege.	3,108
Kearney.	7,702
McCook.	4,303
Nebraska City.	6,279
Oakland.	1,356
Ord.	2,143
Pawnee.	1,595
Red Cloud.	1,856
St. Edward.	1,092
Seneca.	476
Seward.	2,368
Spencer.	728
York.	5,388
OKLAHOMA	
Ada.	8,012
Altus.	4,498
Cushing.	6,326
Duncan.	3,463
El Reno.	7,737
Eufaula.	2,286
Hobart.	2,936
Mangum.	3,405
Marlow.	2,276
Marietta.	1,977
Miami.	6,802
Newkirk.	2,533
Norman.	5,004
Nowata.	4,471
Pauls Valley.	3,694
Pawhuska.	6,414
Pawnee.	2,418
Perry.	3,154
Ponca City.	7,051
Sand Springs.	4,076
Stillwater.	4,701
Sulphur.	3,667
Vinita.	5,010
Wagoner.	3,436
Walters.	3,032
Wynnewood.	2,200
Yale.	2,601
TEXAS	
Athens.	3,276
Ballinger.	2,767
Bartlett.	1,731
Bonham.	6,008
Brownwood.	8,223
Bryan.	6,307
Burkburnett.	5,300
Childress.	5,003
Cisco.	7,422
Clarksville.	3,500
Commerce.	3,842
Cooper.	2,563
Crockett.	3,061
Dalhart.	2,676
Denton.	7,626
Eastland.	9,368
Electra.	4,744
Ennis.	7,224
Gainesville.	8,648
Grand Saline.	1,528
Hereford.	1,696
Hillsboro.	6,952
Honey Grove.	2,642
Jacksonville.	3,723
Jefferson.	2,549
Longview.	5,713
Lubbock.	4,051
Lufkin.	4,878
Marlin.	4,310
McKinney.	6,677
Memphis.	2,839
Mexia.	3,482
Mount Pleasant.	4,099
Nacagodoches.	3,546
Plainview.	3,989
Quanah.	3,691
Terrell.	8,349
Waxahachie.	7,958
Weatherford.	6,203

SAN ANTONIO SEWER PIPE WORKS, San Antonio, Texas, U. S. A.

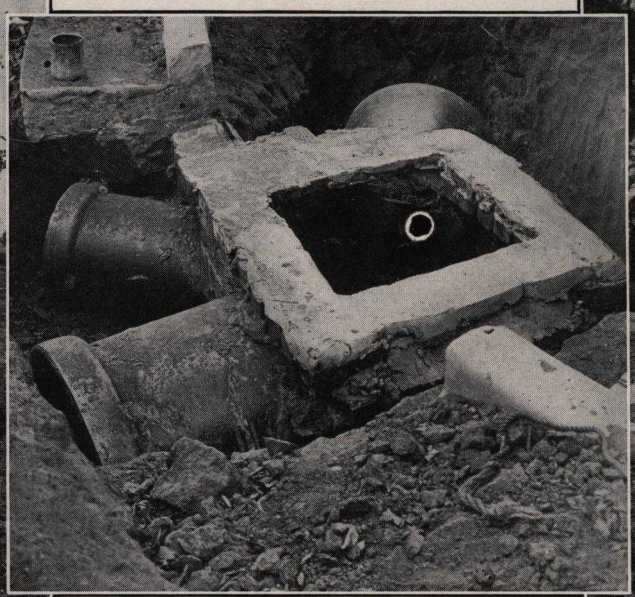
Invert of Dickey Segment Block Storm Sewer, Hogansville, Georgia.

30-inch Dickey Segment Block Storm Sewer constructed for American Textile Mills, Atco, Bartow County, Georgia. Vitrified, Salt Glazed, Clay Sewer Pipe also used. E. S. Draper, Engineer, Charlotte, N. Car. Walker Electric and Plumbing Co., Contractors, Atlanta, Georgia.

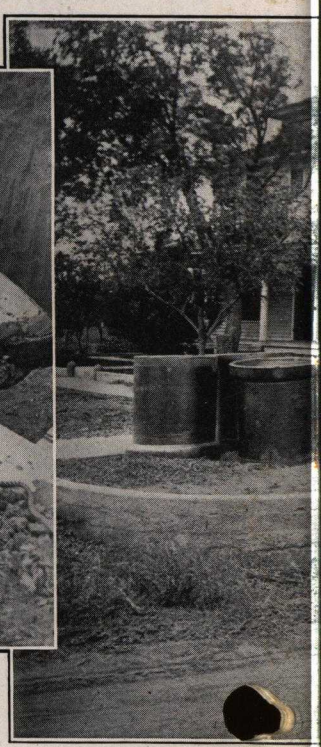
Dickey Segment Block S
Missouri. Sewer laid



Line of Vitrified, Salt Glazed, Clay Storm Sewer, St. John, Kansas.



Storm Sewer inlet through curbing, St. John, Kansas. W. B. Rollins, Engineer, Kansas City, Missouri Cook and Ransom, Contractors, Ottawa, Kansas.

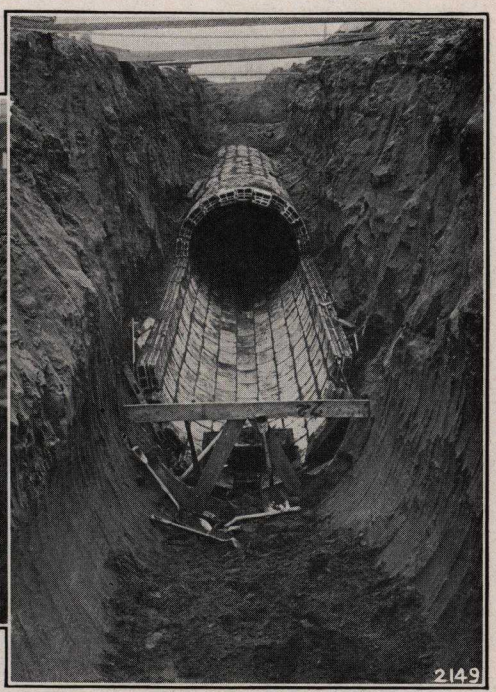


24-inch Vitrified, Salt Gla
for Storm Sewers at St.

SAN ANTONIO SEWER PIPE WORKS, San Antonio, Texas, U. S. A.

rm Sewer, Kansas City,
n curve through rock.

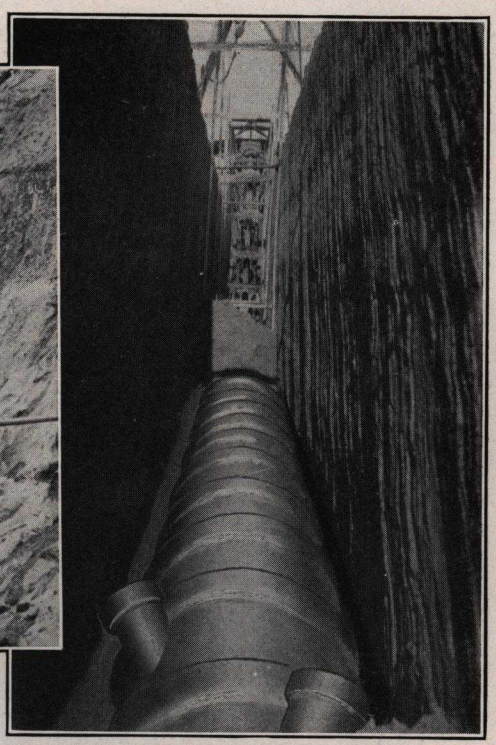
36-inch Segment Block Storm Sewer installed at McComb, Mississippi. X A. Kramer, Engineer. This Storm Sewer was built in connection with the construction of brick pavement. Both were included in the same improvement project.



Invert and finished circle of 72-inch Dickey Segment Block Sewer, Wichita Falls, Texas.

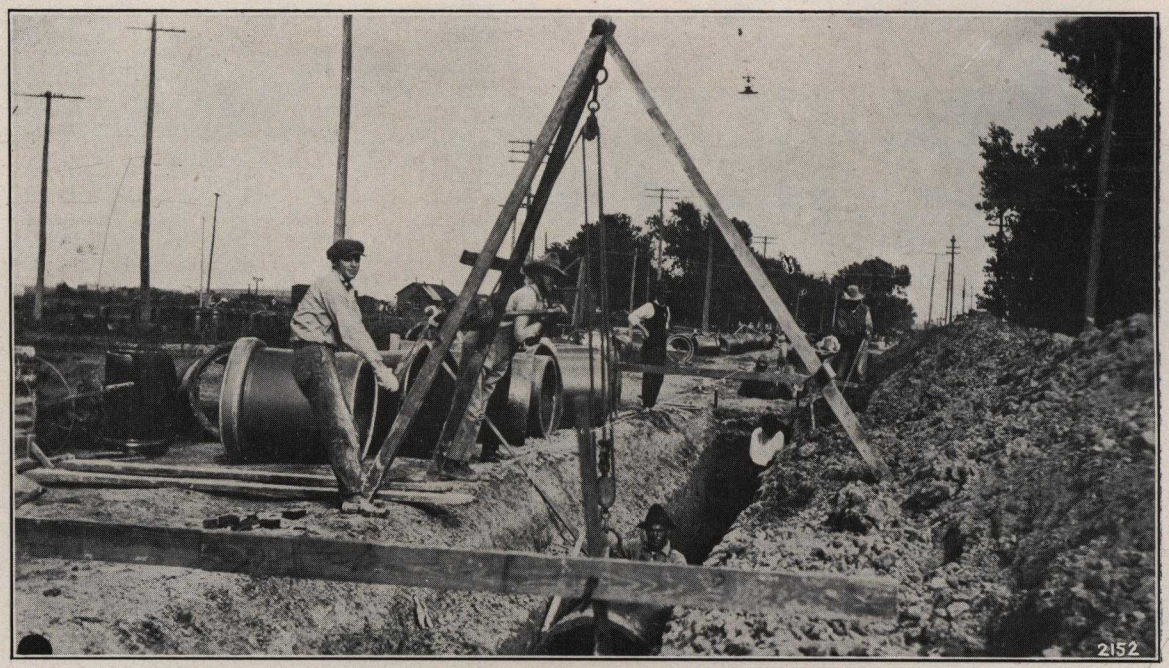
ed, Clay Sewer Pipe used
ohn, Kansas.

33-inch Dickey Segment Block Storm Sewer, Ord, Nebraska. Rohrbaugh Engineering Co, Engineers, Omaha, Nebraska. Hammen-Kruse Construction Co., Contractors, Spencer, Iowa.



Deep cut construction at Ord, Nebraska. Vitrified, Salt Glazed, Clay Pipe used for Storm Sewer.

SAN ANTONIO SEWER PIPE WORKS, San Antonio, Texas, U. S. A.



Cut No. 2152—Installing Vitrified Salt Glazed, Clay Sewer Pipe for Storm Sewers at Chadron, Nebraska. Salisbury Engineering Co., Engineers, Denver, Colo. Ford Paving Co., Contractors, Cedar Rapids, Ia.

It Is Not Necessary to Experiment with Materials for Storm Sewers

THE FIRST requisite in a material for sewers is that it shall be permanent. Because it is buried underground, it should have lasting qualities which will make it give unimpaired service for years and years. It must not be affected by alternating conditions of wetness and dryness. It must not absorb moisture which will freeze and expand, causing disintegration. It must withstand the attacks of acids and alkalis. The cost of digging up a sewer and replacing it is prohibitive. Timely repairs cannot be made because defects are not known about until complete failure has occurred. An underground sewer is the last place anyone should choose to make experiments with questionable materials, even though he be using his own hard earned money. Much less should he risk the funds provided by the citizens of a community.

No risk need be taken, however. Vitrified Salt Glazed Clay has withstood the tests imposed by time, acids, decay, frost, heat and electrolytic action. It is permanent both above and below the ground. It will not rot, rust, corrode, decay, nor disintegrate. It is superior to any other material ever used or substituted for it.

Vitrified Clay Is Adapted To Underground Sewers

Vitrified, Salt Glazed, Clay Sewer Pipe excels for Storm Sewers because of its very character and composition. The clay is subjected to long sustained and intense burning heat which forms a dense, hard, vitreous body unlike any other material except chinaware. The heat destroys every perishable atom in the clay. A smooth, glassy, salt glaze is fused onto the vitrified body and becomes a part of it. This glaze on inside and outside surfaces is impervious to moisture and resists acids and alkalis. The smoothness of Salt Glazed Clay adds to the carrying capacity by reducing friction. It also helps to prevent clogging, because it is self scouring and there are no incrustations formed on the surface which will cause debris to lodge or deposits of dirt to collect.

SAN ANTONIO SEWER PIPE WORKS, San Antonio, Texas, U. S. A.

Using No. 2 Vitrified Pipe Lowers Cost

WE HAVE furnished our No. 2 grade of pipe for many Storm Sewer jobs, both in past years and recently. This has been done very largely on specifications of competent Engineers and not at our request. This No. 2 pipe has the same characteristic qualities as all Vitrified, Salt Glazed Clay. The pressing, drying and burning process is identical. It is graded out of No. 1, because of slight defects which exempt it from being used for the exacting duty of Sanitary Sewer Pipe, but do not disqualify it for permanent and successful service as Storm Sewer Pipe. The difference in price is an item which appeals to Engineers, Officials and Citizens alike.

When capacities are required larger than those of the large sizes of Sewer Pipe, Vitrified, Salt Glazed, Clay Segment Blocks are furnished, as indicated by the many installations pictured in this book.

Cut No. 2153—24-inch Vitrified, Salt Glazed, Clay Sewer Pipe. Also made in sizes from 4-inch to 36-inch.

Engineers Specify No. 2 Sewer Pipe

From letter written by Ruckel Engineering Company, Hutchinson, Kansas, March 29, 1922:

"To date we have constructed some ten miles of Storm Sewers with either Vitrified Pipe or Segment Block. Where Vitrified Pipe is used, we find that classification known as No. 2 is sufficiently good for this class of work."

From letter written by W. S. Shields, Consulting Engineer, Chicago, Illinois, July 16 1915:

"Referring to your inquiry of the 14th, regarding the use of No. 2 Sewer Pipe for Storm Sewers, wish to state that we have used a large amount of this material, preferring it to standard drain pipe on account of its low cost and superiority. The superiority lies in the fact that in constructing storm water drains to carry a given capacity of water, it is very essential that the joints remain in alignment. This is made possible by using socket pipe. It is scarcely possible with the drain pipe. Theoretically it is, of course, but practically, so many joints of the pipe are to be laid that it is impossible to get all of them imbedded in concrete or brick foundations in such a way as to prevent some settling because of earth pressure. We usually find that No. 2 pipe compares favorably in price with the best grade of straight drain pipe. In my opinion it is worth considerable to municipalities on account of the excellent joints made possible by the bell ends."

From letter written by Edwin Main, City Engineer, Rockford, Ill., July 15th, 1915:

"In reply ti your recent communication asking what we did with the No. 2 Sewer Pipe purchased from you, will state that we do not use anything but No. 2 pipe for Storm Sewers, and find it equal to No. 1 for this purpose. This also includes Storm Sewer under pavements and we are now making estimates for brick pavement and macadam which specify No. 2 Sewer Pipe from 12-inch to 27-inch size."

From letter written by Edwin Main, Chief Engineer, Rockford & Interurban Railway Co., Rockford, Ill., April 14th, 1922:

"In reply to your communication of April 11th, asking whether or not my opinion of No. 2 pipe is the same as stated in my communication of July 15th, 1915, will say that I have had no reason for changing my opinion of same, as I have yet to hear of a single failure of No. 2 Sewer Pipe for Storm Water Sewers ad I specify the use of same to replace wooden culverts on our interurban lines."

Table Giving the Carrying Capacity of Pipe, on Stated Fall, in Gallons per Minute

Size o Pipe Inside Diameter	Area of Cross-Section of Pipe in Inches	GALLONS PER MINUTE							
		Fall to 100 ft.	2 in. Fall to 100 ft.	3 in. Fall to 100 ft.	6 in. Fall to 100 ft.	9 in. Fall to 100 ft.	12 in. Fall to 100 ft.	24 in. Fall to 100 ft.	36 in. Fall to 100 ft.
4 in.	12	27	38	47	66	81	93	131	163
6 in.	28	75	105	129	183	224	258	364	450
8 in.	50	153	216	265	375	460	527	750	923
10 in.	78	267	378	463	655	803	926	1310	1613
12 in.	113	422	596	730	1033	1273	1468	2076	2554
15 in.	177	740	1021	1282	1818	2224	2464	3617	4467
18 in.	254	1161	1651	2022	2860	3508	4045	5604	7047
21 in.	345	1699	2399	2940	4157	5100	5880	8261	10416
24 in.	452	2396	3387	4152	5871	7202	8303	11744	14466
27 in.	572	4407	6211	7674	10883	13257	15344	21771	26622
30 in.	708	5006	8352	10223	14298	17714	20204	28129	35513
33 in.	855	6900	9150	12068	17160	21008	24217	34305	48860
36 in.	1020	9707	13769	16816	23736	29284	33722	47523	58406

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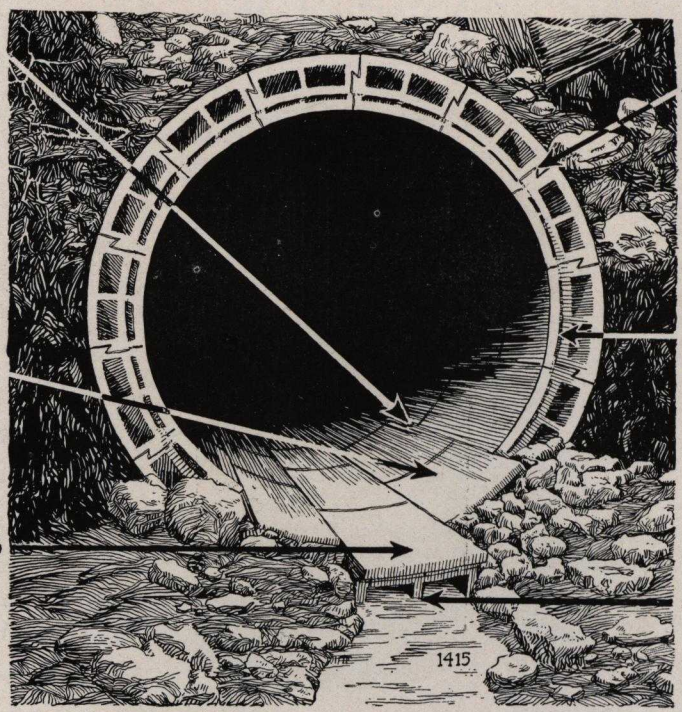


Dickey Segment Blocks

Six Points of Superiority

FOR YOUR close scrutiny and consideration we call your attention to the following **Six Points** that make our Segment Blocks the ideal material, with which to construct Sewers, Drains and Conduits of large diameters.

Alternate Courses Staggard. This feature assures strength of structure as there will be no two adjacent rows of blocks where the end joints do not lap half the length of the block.

Blocks 24" Long. This displaces 25 ordinary brick and it is obvious that the labor cost will be cut down proportionately.

Salt-Glazed Indestructible Surface. This insures the permanency of this type of construction. The coefficient of friction will remain constant, for the Salt Glazed Clay is not affected by the gases or acids and will not erode. On no other type of construction can you figure on this. Think what it will mean to design a sewer with a calculated capacity and find when it has been in operation a few years that the invert has disintegrated and worn away. The best rule is to specify the material that has been proven indestructible through years of time in service.

Side Joints Self Centering and Inter-locking. The dove tail male and female joints on the sides of the block insure perfect mortar joints.

Ship Lapped End Joints. The ship lapped end joints form a mortar key for each block. This makes a water tight structure.

Under Drain. An under drain that really drains. This feature alone has made more friends for our Segment Blocks than any other. It insures dry joints, takes care of the seep water that is always present.

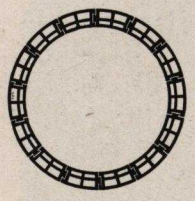
SAN ANTONIO SEWER PIPE WORKS, San Antonio, Texas, U. S. A.

Dickey Vitrified Salt Glazed Segment Blocks

Type "B"

Size Inches	No. Blocks to Circle	No. Blocks per Ft.	DIMENSIONS INCHES			Weight per Sewer Foot Lbs.
			Width	Length	Thickness	
30	10	5	9¼	24	4¾	290
33	11	5½	9¼	24	4¾	320
36	12	6	9¼	24	4¾	350
39	13	6½	9¼	24	5½	420
42	14	7	9¼	24	5½	470
45	15	7½	9¼	24	5½	450
48	14	7	10½	24	6	475
51	15	7½	10¼	24	6	500
54	16	8	10¼	24	6	555
57	17	8½	10 3/16	24	6¾	715
60	18	9	10 3/16	24	6¾	755
66	20	10	10 3/16	24	6¾	845

The thickness of the walls and webs of all types are accurately designed to meet the heaviest duty to which the respective sizes can be subjected.



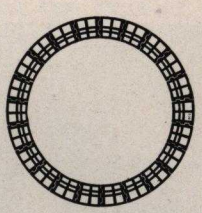
42-inch circle of Type "B" Segment Block Sewer.

Type "B" Block

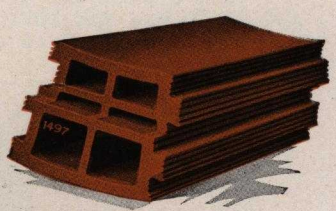
For sizes 30, 33, 36, 39, 42, 45, 48, 51, 54, 57, 60 and 66 inches.

Type "A"

Size Inches	No. Blocks to Circle	No. Blocks per Ft.	DIMENSIONS INCHES			Weight per Sewer Foot, Lbs.
			Width	Length	Thickness	
72	22	11	10	24	7⅞	1100
78	24	12	10	24	7⅞	1200
84	26	13	9⅞	24	8¼	1300
90	28	14	9⅞	24	8¼	1400
96	28	14	10½	24	8½	1600
102	30	15	10½	24	8½	1700
108	30	15	11⅛	24	10½	1800



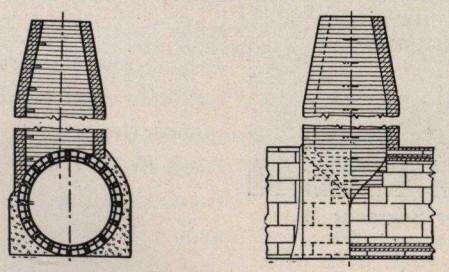
72-inch circle of Type "A" Segment Block Sewer.



Type "A" Block

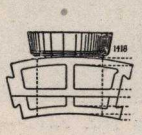
For sizes 72, 78, 84, 90, 96, 102 and 108 inches.

Manholes



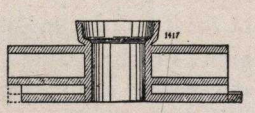
Sections through manholes in connection with Segment Block Sewers.

Junctions



End View

Segment Block Junction.



Side View

Segment Block Junction.

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Construction Forms for Segment Blocks

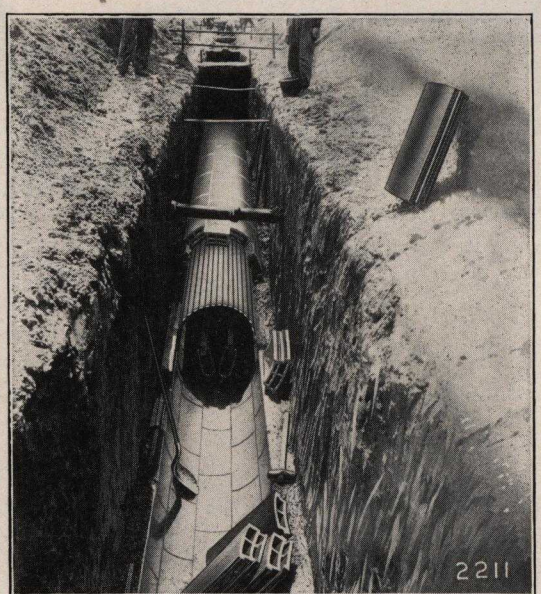
Templates of the proper radius are used in laying the Segment Blocks in the lower half of the Sewer. Guide lines, stretched from nails which are accurately spaced, make it easy to lay the blocks properly.

Arch Form for Segment Blocks

Arch Form used in constructing Dickey Segment Block Sewers in open trench. These forms are 8 feet long and are raised and lowered by wedges. We supply Forms, Templates and Tampers for all sizes of Sewers. A charge is made for each Form shipped, and credited back when Form is returned, after freight has been paid.

Rapid Construction Accomplished

Dickey Vitrified Salt Glazed, Segment Blocks are equally well adapted to rapid construction, whether in deep cuts or shallow ditches. The work moves along rapidly because the blocks are at least 9¼ inches wide and 24 inches long. At the same time a permanent and substantial sewer is the result.



Cut No. 2211—30-inch Dickey Segment Block Storm Sewer Construction at Florence, South Carolina. Finishing Arch over Arch Form. Nesbit Wingfield, Consulting Engineer, Augusta, Georgia. Adams and Ervin, Engineers, Florence, South Carolina. Chitwood and Palmer, Contractors, Columbia, South Carolina.

Economical Work Insured

Dickey Segment Block construction is economical, both because it can be done rapidly and also because expensive skilled labor is not required. Lines and Templates guide in the construction of the invert. The Arch Form controls the turning of the crown or arch.

SAN ANTONIO SEWER PIPE WORKS, San Antonio, Texas, U. S. A.

Approval from an Authoritative Source

CONSULTING Engineers do not give public approval to materials unless their experience has been such as tc overcome their doubts. It is a good thing that they do withhold their final approval in this manner. The public takes their opinion at a much higher value because of that very fact. When an Engineer of the standing enjoyed by Mr. Alexander Potter expresses his approval of Vitrified Segment Blocks for large Storm Sewers, we may be sure that they are of high quality and well adapted to the purpose.

TELEPHONE
5501 CORTLANDT

CABLE ADDRESS
"ALEXPOTTER"

ALEXANDER POTTER, C.E.
CONSULTING AND CONSTRUCTING ENGINEER
HYDRAULICS SANITATION REINFORCED CONCRETE
HUDSON TERMINAL BUILDING
50 CHURCH ST. NEW YORK

December 3rd, 1918.

American Sewer Pipe Co.,
Thirty Church Street,
New York City, N. Y.

Gentlemen:-

In response to your inquiry, I would say that in January of this year as Consulting Engineer to the Designing Engineers, I recommended the adoption of your segment block for sewers and drains at the Government Explosives Plant at Nitro, West Virginia, as offering the best material for the peculiar conditions to which the sewers in that plant would be subjected; namely, the possible deterioration of whatever joining material might be used in the construction of the sewers and drains, due to the influence of acid wastes. This work involved the use of 32,763 linear feet of segment block in sizes ranging from 27 inches to 84 inches inclusive.

The only open question in my mind at the time of my recommendation was the effect of internal pressure in opening up and rupturing the joints when the river would be in flood. I did not have long to wait for a chance to determine this effect, for on March 14th the country in the vicinity of Nitro was visited by a severe rainstorm and flood, a higher flood than had been known in that vicinity for some time.

The City of Charleston, situated on the Kanawha River, sixteen miles above Nitro, had used a great deal of your segment block in the construction of their large sewers, built at great depth. As soon as the flood waters receded sufficiently to permit it, I made a personal inspection of all the large Charleston sewers which had been subjected to internal pressure during extreme flood conditions. I walked through these sewers with the City Manager and the City Engineer. Some of the Charleston sewers had been built several years ago, but one of the main sewers, fifty-four inches in diameter, had been so recently completed that it had never before been subjected to internal pressure. The sewers were found to be in perfect condition, free from any crack with the exception which is noted hereafter, and this notwithstanding the fact that the sewers had been subjected in some cases to an internal head of water in excess of twenty feet. The exception just referred to was a relatively short piece of sewer which had been carelessly backfilled and upon this section a line of joints along the crown of the sewer was opened up in an amount varying from a hair crack to a sixteenth of an inch; otherwise all the segment block sewers were in perfect condition throughout.

From my personal examination of the Charleston sewers, I can heartily recommend this class of construction for large sewers both storm and sanitary.

I am

Yours very truly,

AP-BS

Alexander Potter

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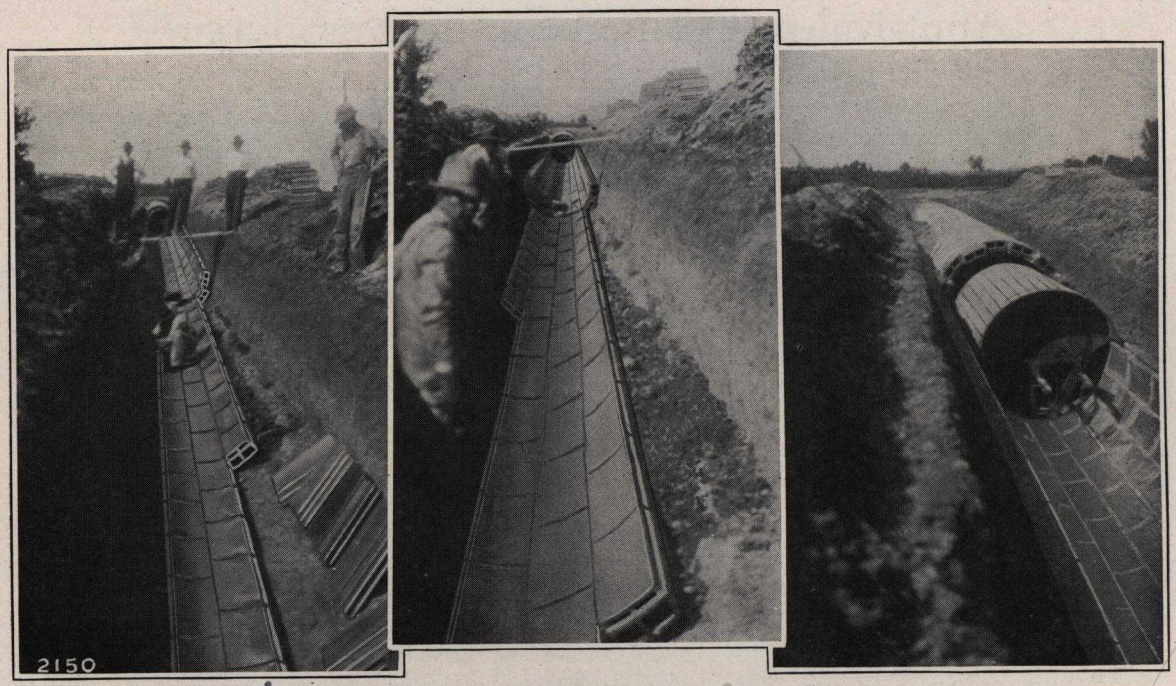

Cut No. 2150—Dickey Segment Block Storm Sewer Hiawatha, Kansas. Progressive photographs showing work from starting of the invert to comple ion of the arch. Black and Veatch, Consulting Engineers, Kansas City, Mo.

Cut. No. 2157—Installing Storm Sewers of Dickey Segment Blocks at Broken Bow, Nebraska, a town of 2,567 inhabitants. Note the curve in the picture at left. Grant, Fulton and Letton, Engineers, Lincoln, Nebr. Smith and Chambers, Contractors, Scottsbluff, Nebr.

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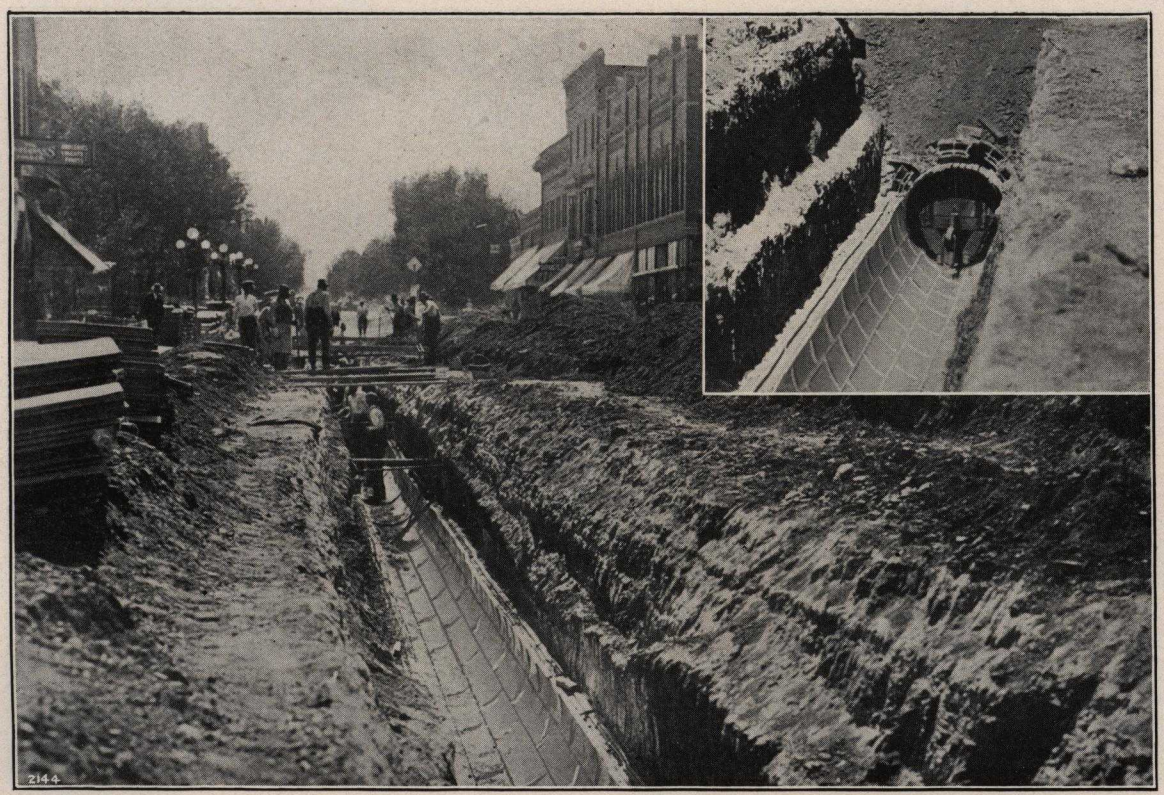
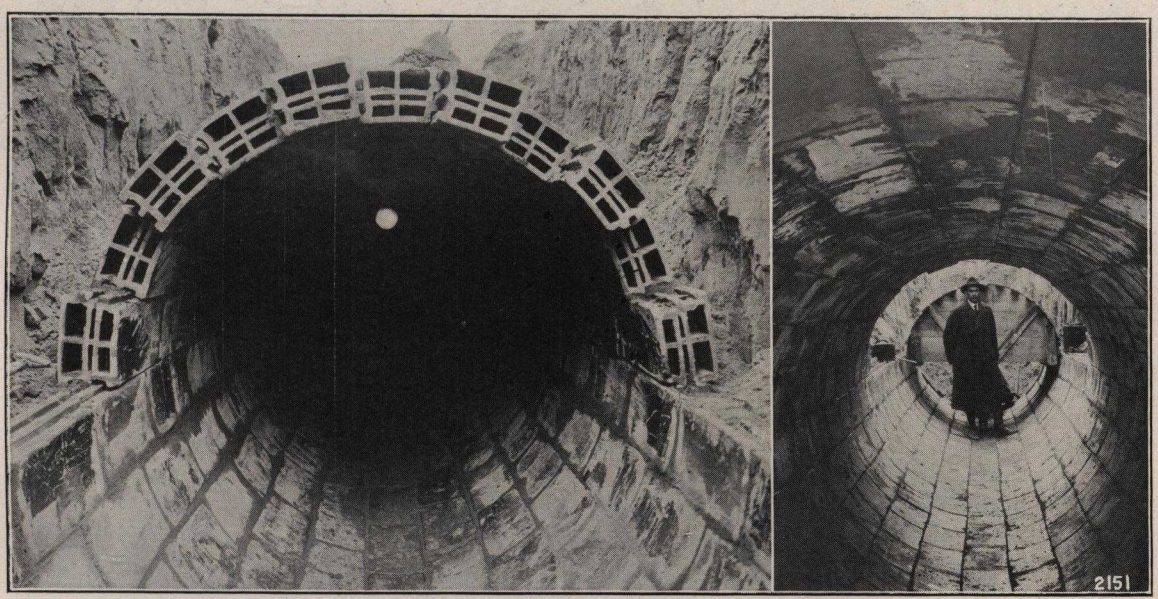
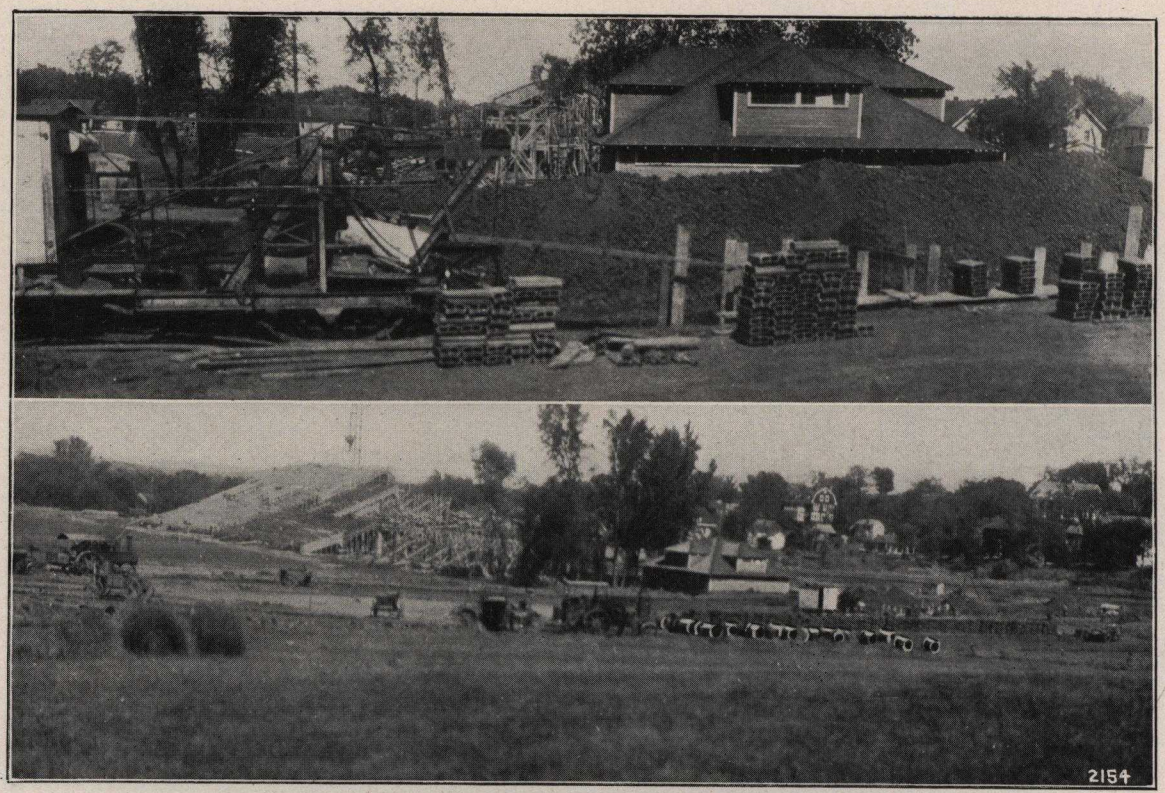


Cut No. 2144—Installing Dickey Segment Blocks in Storm Sewer at La Junta, Colorado. Insert above shows completed arch turned over Arch Form. W. E. Baldry, Consulting Engineer, Topeka, Kans. F. T. Lewis, City Engineer. Dennis Gibbons and Sons, Contractors, Denver, Colo.



Cut. No. 2151—Large Storm Sewer at Wichita Falls, Texas. Dickey Segment Blocks, Type "A," used for 72-inch diameter. Julien Montgomery, City Engineer. C. H. Foley, Contractor, Wichita Falls, Tex.

SAN ANTONIO SEWER PIPE WORKS, San Antonio, Texas, U. S. A.



Cut No. 2154—Construction of drainage system under University Stadium Field at Kansas State University, Lawrence, Kansas. Large Storm Drain constructed of Dickey Segment Blocks. Vitrified Sewer Pipe used for laterals and sub-surface drainage under gridiron and running track. L. H. Dodd, Consulting Engineer, Engineering Dept., Kansas University. Unit Construction Co., General Contractors, St. Louis, Mo. O'Neil Construction Co., Sub-Contractors, Leavenworth, Kans.

Storm Sewers and Drains Put Athletic Fields Into Condition Rapidly

ATHLETIC FIELDS for Schools Colleges, Universities, Cities and great Industrial Institutions are being multiplied in all sections of the country.

Games Must Be Played On Schedule

Their use is not confined to a few dry weather months. Rain or snow water must be removed to promote quick drying and tc put the ground in condition for games, contests, pageants, etc., which are scheduled, widely advertised, and will draw immense crowds from long distances.

Year Round Service

Engineers, Architects and Officials should give large consideration to drainage, and sub-surface drainage in particular, for all such Athletic Fields. In order to make such a large investment pay in available efficiency throughout the year, it is necessary to provide a system of Storm Sewers and underdrains to expedite rapid drainage. Quick and thorough drying is best accomplished when the excess moisture in the soil is drained out from below in addition to surface drainage.

Vitrified Drain Tile, Sewer Pipe and Segment Blocks are a triple team to do the entire job satisfactorily and permanently. Remember this—if materials are used which will rot, rust, disintegrate, or decay, it will be necessary some day to dig up the field again to replace the useless pipe. Use Vitrified Clay, the material which will never need replacement.

SAN ANTONIO SEWER PIPE WORKS, San Antonio, Texas, U. S. A.

Larger Carrying Capacity in Segment Block Sewers

It is well known among engineers that sewers built of other materials, which have a rougher surface than Salt Glazed, Vitrified Clay, cannot have as great a carrying capacity for equal size. This difference in capacity in favor of Salt Glazed Vitrified Clay is much greater than is sometimes realized.

In order to make the difference clearly evident we show a comparison between a few sizes, contrasting the capacities. .013 is commonly adopted as the co-efficient of friction for Salt Glazed Segment Blocks, while .015 is for rougher materials.

Calculated on a Grade of 1% or a Fall of 1 Foot in 100 Feet

Diameter of Sewer	N	Velocity in ft. per sec.	Discharge in cu. ft. per sec.
24 in	.013	7.21	22.7
24 in	.015	6.058	19.03
48 in	.013	11.7	147.
48 in	.015	9.99	125.5
60 in	.013	13.5	264.8
60 in	.015	11.33	222.5
84 in	.013	16.97	653.
84 in	.015	13.79	530.
96 in	.013	18.4	925.
96 in	.015	15.9	799.

In the tables below, we show the carrying capacities of Segment Block Sewers calculated from Kutter's formula, using different percentages of grade or fall.

KUTTER'S FORMULA

Kutter's formula for measure in feet is:

$$V = \left\{ \frac{\frac{1.811}{n} + 41.6 + \frac{0.00281}{s}}{1 + (41.6 + \frac{0.00281}{s}) \times \frac{n}{\sqrt{r}}} \right\} \times \sqrt{rs}$$

v = mean velocity in feet per second

$r = \frac{a}{b}$ = hydraulic mean depth in feet or cross sectional area in square feet divided by wetted perimeter in lineal feet.

s = fall of water surface (h) in any distance (l) divided by that distance $\frac{h}{l}$ = sine of slope.

n = co-efficient of friction.

The following Velocities, for the most part, were taken from Hydraulic and Excavation tables, published by the U. S. Reclamation Service. Q, the discharge in cubic feet per second, is figured from the equation, Q = A. V. N, the co-efficient of friction used in Kutter's formula, being taken as .013 for Segment Blocks.

Diameter of Sewer in Inches	Area in Sq. Ft.	1.02 inches of fall to 100 ft. S- .00085		1.51 inches of fall to 100 ft. S- .00126		2.1 inches of fall to 100 ft. S- .00175		2.4 inches of fall to 100 ft. S- .002		3.6 inches of fall to 100 ft. S- .003	
		V.	Q.	V.	Q.	V.	Q.	V.	Q.	V.	Q.
30 in	4.908	2.45	12.	2.97	14.6	3.51	17.2	3.77	18.5	4.63	22.7
33 in	5.939	2.57	15.3	3.17	18.8	3.76	22.4	4.06	24.	4.94	29.4
36 in	7.0685	2.75	19.4	3.37	23.8	4.	28.4	4.29	30.3	5.25	37.1
39 in	8.2957	2.94	24.4	3.58	29.8	4.23	35.2	4.54	37.6	5.56	46.
42 in	9.621	3.09	29.8	3.75	36.	4.46	42.6	4.76	45.7	5.85	56.3
45 in	11.044	3.24	35.8	3.94	43.5	4.67	51.8	5.	55.3	6.13	68.
48 in	12.566	3.39	42.5	4.13	52.	4.89	61.4	5.23	65.7	6.42	80.4
51 in	14.186	3.53	50.	4.3	61.	5.	71.	5.44	77.	6.64	94.2
54 in	15.904	3.64	57.9	4.46	71.	5.25	83.5	5.66	90.	6.94	110.
57 in	17.72	3.81	67.5	4.64	82.1	5.49	97.3	5.87	104.	7.20	127.3
60 in	19.635	3.94	77.2	4.8	94.3	5.68	111.4	6.08	119.	7.46	146.4
66 in	23.758	4.21	100.	5.12	121.4	6.05	143.4	6.48	153.8	7.95	188.7
72 in	28.274	4.45	125.8	5.42	153.	6.41	181.	6.86	194.	8.4	237.
78 in	33.183	4.73	157.2	5.7	189.9	6.75	224.	7.23	241.	8.86	294.6
84 in	38.484	4.93	190.	5.96	230.	7.	270.	7.58	292.	9.29	357.5
90 in	44.178	5.15	226.9	6.26	276.6	7.42	328.	7.94	350.5	9.71	429.
96 in	50.265	5.38	271.5	6.53	328.	7.73	388.5	8.27	416.	10.1	508.
102 in	56.745	5.59	317.3	6.79	385.	8.03	455.1	8.59	487.	10.54	598.
108 in	63.62	5.8	369.2	7.05	448.	8.34	530.	8.91	566.	10.95	696.

Diameter of Sewer in Inches	Area in Sq. Ft.	4.8 inches of fall to 100 ft. S- .004		6 inches of fall to 100 ft. S- .005		7.2 inches of fall to 100 ft. S- .006		9.6 inches of fall to 100 ft. S- .008		12 inches of fall to 100 ft. S- .01	
		V.	Q.	V.	Q.	V.	Q.	V.	Q.	V.	Q.
30 in	4.908	5.35	26.2	6.	29.3	6.56	32.	7.57	36.9	8.47	41.5
33 in	5.939	5.71	34.	6.4	38.	7.	41.5	8.1	48.	9.02	53.5
36 in	7.0685	6.07	42.8	6.8	48.	7.46	52.7	8.6	60.8	9.63	68.
39 in	8.2957	6.42	53.2	7.2	59.8	7.89	65.2	9.11	75.3	10.2	84.6
42 in	9.621	6.75	64.9	7.58	72.9	8.29	79.6	9.57	92.	10.68	102.7
45 in	11.044	7.13	78.4	7.93	87.2	8.7	95.7	10.04	110.9	11.2	123.7
48 in	12.566	7.41	93.	8.3	104.	9.	113.	10.5	131.9	11.7	147.
51 in	14.186	7.71	109.3	8.64	122.5	9.45	134.	10.75	152.	12.17	172.
54 in	15.904	8.	127.6	8.93	142.	9.77	155.3	11.28	179.2	12.6	200.
57 in	17.72	8.32	147.2	9.14	161.9	10.2	180.7	11.65	206.2	13.13	230.3
60 in	19.635	8.6	168.8	9.63	189.	10.48	205.	12.2	239.8	13.5	264.8
66 in	23.758	9.1	218.	10.2	242.	11.28	267.	12.9	306.	14.4	341.7
72 in	28.274	9.7	274.	10.8	305.8	11.7	330.8	13.6	382.	15.3	433.
78 in	33.183	10.2	338.3	11.4	378.	12.4	411.6	14.45	479.6	16.2	537.
84 in	38.484	10.7	412.	11.97	461.	13.15	506.	15.2	585.5	16.97	653.
90 in	44.178	11.2	496.	12.5	552.2	13.74	607.	15.93	705.4	17.8	786.3
96 in	50.265	11.7	585.	13.1	658.4	14.3	720.	16.5	830.	18.4	925.
102 in	56.745	12.14	689.	13.6	771.	14.86	843.5	17.2	965.	19.19	1089.
108 in	63.62	12.62	803.	14.1	896.	15.42	983.4	17.85	1137.	19.9	1268.

Maximum, Minimum and Average Rainfall Statistics

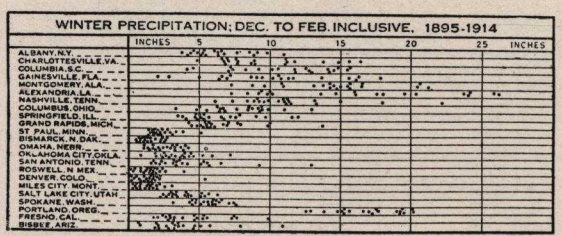
The tabular schedule below is given as being suggestive rather than final and conclusive evidence concerning rainfall. The figures are taken from U. S. Government Weather Bureau Bulletins and Reports. The figures we list are given to show that the rainfall is variable both in annual and seasonal amounts from year to year. They also indicate that the opinions of local inhabitants based on memory and tradition are not to be considered exclusively, but must be compared with more accurate statistics such as the Weather Bureau compiles. It should be borne in mind that heavy downpours lasting from five to fifteen minutes are not uncommon. They sometimes register as much as 3½ to 4 inches of rain per hour.

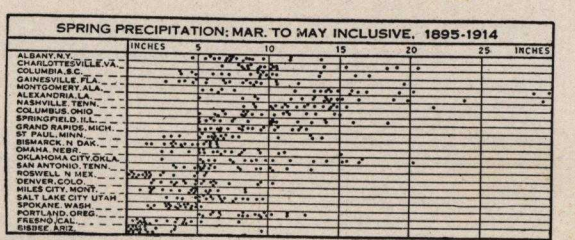
The maximum figures clearly demonstrate, we believe, that Storm Sewers are very necessary if streets and pavements are to give proper and permanent service.

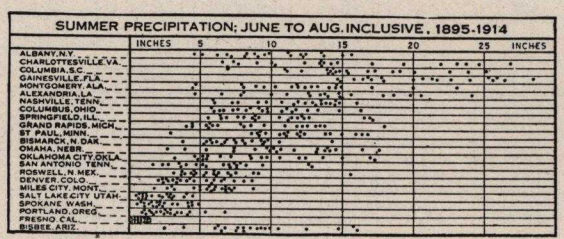
State	Year	Number of Rainy Days (.01 inch or More) at Any Recording Station		Greatest Precipitation at Any Recording Station in One Month		Maximum and Average Annual Recorded Precipitation			
		Greatest	Least	Inches	Month	Period of Years	Greatest Annual Rainfall		Average Annual Rainfall for Period in Inches
							Year	Inches	
Alabama.	1921	128	35	10.87	April	30 yrs	1900	66.73	52.83
Arkansas.	1921	120	47	12.95	Nov.	31 yrs	1892	57.75	48.01
Colorado.	1921	143	37	5.96	April	34 yrs	1909	20.96	16.46
Florida.	1921	131	53	31.34	Oct.	30 yrs	1905	61.43	52.31
Georgia.	1921	140	59	19.39	July	30 yrs	1912	63.02	49.43
Illinois.	1921	129	82	11.18	Nov.	27 yrs	1898	46.	34.78
Iowa.	1921	113	60	11.95	Sept.	32 yrs	1902	58.80	31.72
Kansas.	1921	102	39	12.56	June	35 yrs	1902	36.08	27.30
Kentucky.	1921	144	66	13.07	Nov.	32 yrs	1898	52.38	45.55
Louisiana.	1921	121	38	13.96	March	31 yrs	1919	68.97	54.99
Michigan.	1921	170	58	8.32	July	34 yrs	1893	34.55	30.72
Minnesota.	1921	125	50	8.32	Sept.	36 yrs	1905	33.1	27.01
Mississippi.	1921	119	61	20.85	March	34 yrs	1919	69.24	52.70
Missouri.	1920	118	61	10.21	Aug.	33 yrs	1905	45.43	39.59
Nebraska.	1921	95	41	10.53	May	46 yrs	1881	30.91	23.66
New Mexico.	1921	104	22	9.65	July	30 yrs	1919	20.95	14.37
N. Carolina.	1921	147	57	16.02	June	35 yrs	1901	62.66	50.1
N. Dakota.	1921	119	32	10.	July	30 yrs	1896	23.57	19.98
Oklahoma.	1921	79	35	13.92	June	29 yrs	1908	50.54	31.88
S. Carolina.	1921	125	64	17.17	July	35 yrs	1901	54.98	47.61
S. Dakota.	1921	128	40	10.06	Sept.	31 yrs	1915	28.54	21.20
Tennessee.	1921	155	77	11.64	April	38 yrs	1919	57.65	49.48
Texas.	1921	75	23	17.50	Sept.	30 yrs	1919	45.64	30.27
Virginia.	1920	139	56	11.95	Aug.	29 yrs	1902	51.42	42.43
Wisconsin.	1921	123	65	13.02	July	31 yrs	1911	37.	30.22
Wyoming.	1921	141	8	5.08	June	23 yrs	1915	19.42	14.24

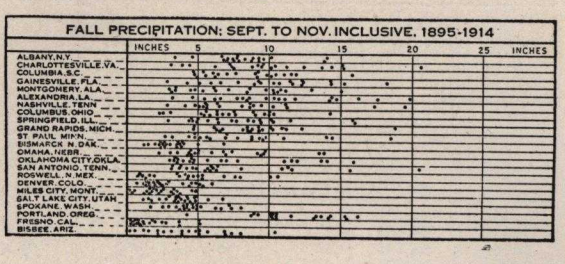
Weather Bureau Charts Showing Seasonal Precipitation During 20 Years, 1895 to 1914

On these graphs, the amount for the season in each of the twenty years is represented by a dot.





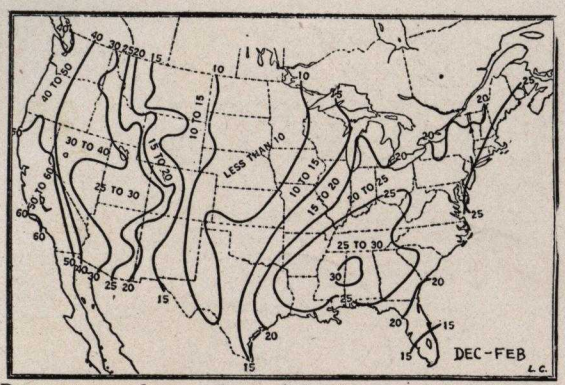




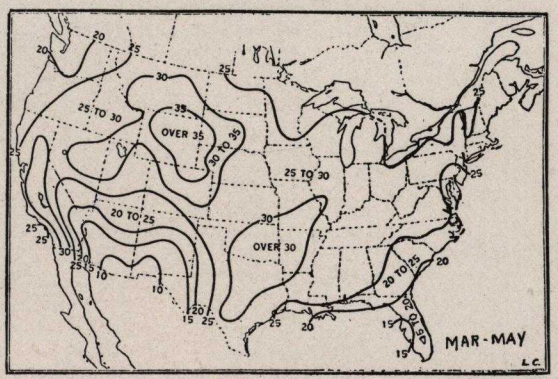
SAN ANTONIO SEWER PIPE WORKS, San Antonio, Texas, U. S. A.

Rainfall Charts Showing Seasonable Percentages

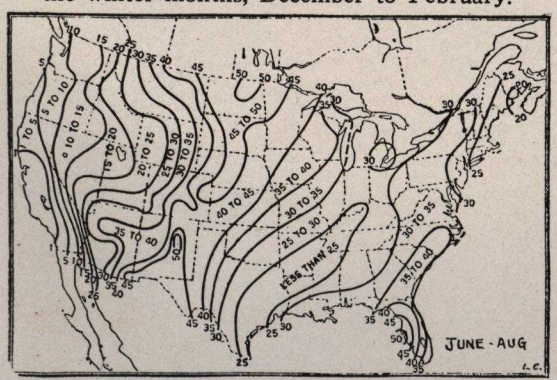
Compiled by U. S. Government. Based on Averages of 20 Years, 1895-1914



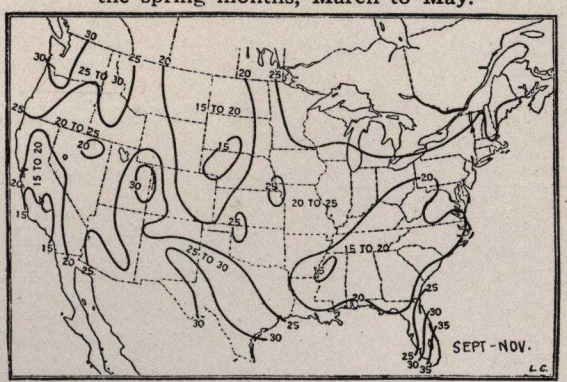
Percentage of annual precipitation occurring during the winter months, December to February.



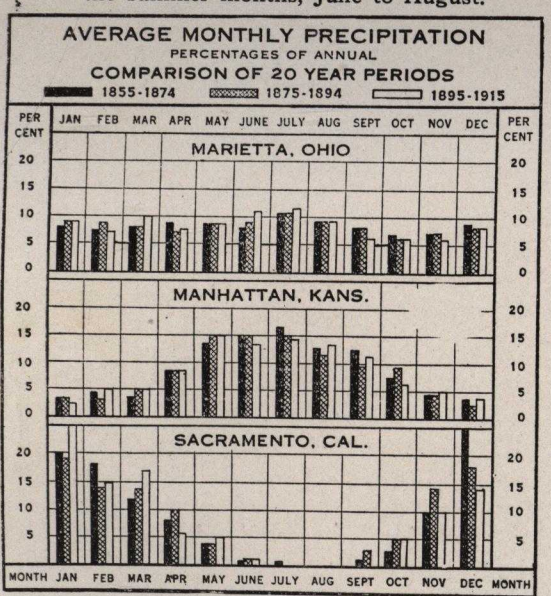
Percentage of annual precipitation occurring during the spring months, March to May.



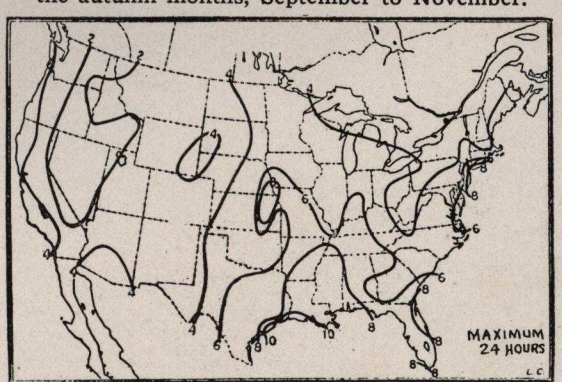
Percentage of annual precipitation occurring during the summer months, June to August.



Percentage of annual precipitation occurring during the autumn months, September to November.



The chart above shows comparisons recorded over long periods at three widely separated Weather Bureau Stations.



Maximum Precipitation in 24 Hours in inches.

In some isolated cases, much heavier rainfall than is indicated on the chart just above has been recorded for 24 hours at substations of the Weather Bureau. However, the chart affords a general picture of the maxium precipitation in 24 hours during the 20 year period covered. as it is drawn to the records of all regular reporting Weather Bureau stations.

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for large sewers and culverts
3 ft. to 9 ft. diameter.
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for conduits or gutters.
Salt-Glazed Well Pipe
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Salt-Glazed Dickey Hollow Tile Silos
Salt-Glazed Hollow Tile Grain Tanks
Salt-Glazed Hollow Tile Corn Cribs
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Salt Glazed Wall Coping
Salt-Glazed Dickey Flashing Blocks
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Established 1895

San Antonio, Texas, U. S. A.

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